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I, JONNE YABSLEY, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. PS 2792 for a patent by SPORTZWHISTLE PTY LTD as filed on 05 June 2002.

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AUSTRALIA

Patents Act 1990

PROVISIONAL SPECIFICATION

Applicant(s):

SPORTZWHISTLE PTY LTD

Invention Title:

TRANSDUCER MOUNTING

The invention is described in the following statement:

TRANSDUCER MOUNTING

FIELD OF THE INVENTION

The present invention relates to arrangements applicable to piezoelectric transducers for the production of sound.

BACKGROUND OF THE INVENTION

Piezoelectric transducers are in common usage in numerous products. They contain a diaphragm typically fabricated by attaching a smaller diameter thin piezoceramic disk onto a larger diameter thin metal disk. Applying a voltage across the piezoceramic disk produces stresses that cause the diaphragm to flex like a drum skin. Diaphragms may be used on their own, as in wrist watches, but they are usually mounted onto an acoustic chamber with an opening to improve the acoustic power output of the transducer. Acoustic power output and/or sound directionality can further be enhanced with a suitably shaped air cavity that behaves like a horn.

One common method of mounting a diaphragm is to glue its nodal circle to a matching cylindrical protrusion that forms part of the acoustic chamber. The nodal circle's length does not change as the diaphragm flexes. Nodal mounting is inexpensive and has low mounting loads but exposes only the diaphragm surface within the nodal diameter to the acoustic chamber. Another common method is to mount the diaphragm by gluing or clamping it around a small peripheral annular region. This has higher mounting loads but exposes a larger portion of the diaphragm to the acoustic chamber and equivalent diaphragm flexing results in the centre deflecting further compared with nodal mounting.

One limiting factor of the acoustic power output is the tensile strength of the piezoceramic. Ceramics are typically much stronger in compression than in tension. Increasing the flexing vibration of the diaphragm by

applying higher voltage waveforms increases acoustic power output. The fatigue life of the transducer depends mainly on the maximum tensile stress experienced by the piezoceramic. Specifying a required fatigue life for a transducer in turn determines the maximum vibrating deflection, the maximum driving voltage waveform and the maximum acoustic power output for a given frequency.

Previously published proposals in the field of transducers include US Patent 6353277 (Han-Jose), US Patent 5514927 (Tichy) and US Patent 5030872 (Boehnke & Pieper). These specifications are representative of particular configurations of transducers for particular purposes but in recognising this prior art no admission is made that any one item discloses any arrangement which is known or of general knowledge in Australia or any other country.

According to the present invention, in one aspect, there is provided an acoustic transducer assembly comprising a generally planar diaphragm having piezoelectric transducer material in a central portion and a mounting flange extending from a peripheral portion transversely to the generally planar diaphragm, and first and second mounting elements engaging and mounting the flange on its inner and outer sides respectively whereby an assembly is adapted to be mounted for acoustic output when the piezoelectric transducer is electrically driven.

Preferably the form of the diaphragm is disc-shaped with the flange being a depending skirt extending approximately at right angles to the general plane of the diaphragm.

In a preferred embodiment the first and second mounting elements are respective rings and the skirt is of corresponding shape to be clamped between the rings in an interference fit.

However, in another form one of the first and second mounting elements is a ring-shaped structure conforming substantially to the peripheral shape of the diaphragm and

the other is a structural support element to which the diaphragm is securely attached.

In a preferred embodiment the diaphragm is a disc of brass or similar material and carries bonded thereto the piezoelectric element, the edges of this element being spaced inwardly from the inner mounting element. However, a wide range of materials may be used in place of brass.

Advantageously the transducer assembly is adapted to be mounted on a support base by a mounting cap which provides an acoustic chamber with an axially directed aperture through which sound is adapted to pass.

It has been found that with embodiments of the invention robustness, durability and high volume of sound generation can be achieved. In particular high applied voltages can be used without damage to the transducer device. It is believed that the mounting structure proposed facilitates resonance and simple mounting.

The inventor proposes the following explanation for the advantages which can be achieved in performance but this explanation is given to assist an understanding of the invention but the inventor is not to be bound by the completeness or correctness of this explanation and theory. It is believed that the form of the mount provides high rigidity and that consequently there is very little hysteresis and energy loss compared with commonly used mounts. Furthermore the rigid mounting is believed to result in greater energy storage capacity for the resonant mass/spring behaviour of the diaphragm for a given maximum piezoceramic tensile stress. Furthermore a compressive preload of the piezoceramic may be provided for as a result of a mechanical flexing preload left over from the drawing operation of the assembly. It is believed this preload may have the effect of permitting a greater stress range for a given maximum piezoceramic tensile stress. Thus the structure is of the nature of a tight drumskin or stretched membrane although the full reasons for improved acoustic power output in this case

are not fully understood.

Embodiments of the invention can utilise low cost parts and low cost assembly operation to produce inexpensive but robust devices yet for a given size of device great acoustic power can be achieved.

For illustrative purposes only an embodiment of the invention will now be described with reference to the accompanying drawings, of which:-

Figure 1 is a plan view of a transducer assembly embodying the invention but shown schematically;

Figure 2 is a cross sectional view taken along the line A-A in figure 1.

Figure 3 is a view in enlarged scale of portion X is Figure 2 illustrating the profile of the preferred embodiment.

Figure 4 illustrates in exploded view the components of the device of figures 1-3 arranged to cooperate with an acoustic chamber; and

Figure 5 is a cross sectional view showing assembly of the device of figure 4.

The illustrated transducer assembly has a transducer disc 12 having a brass mounting plate 12A and a piezoceramic disc 12B bonded to the inner surface as best shown in Figure 2, the mounting 12A having a peripheral skirt 12C which is rigidly mounted interference fit between an inner ring 13 and outer ring 11. The preferred profile of the rings is shown in the enlarged view of Figure 3.

As showed in detail in Figure 3, the inner ring 13 has a curved nose 13A with a part-circular profile extending from an inclined ramp 13B to an outer wall 13C which extends parallel to the axis of the ring. The outer ring 11 has a similar curved nose 11A at its lower inner corner connecting between a transverse wall 11B and an inner wall 11C which also extends substantially parallel to the access of the ring. The profile of the rings is such that the structure shown in Figure 3 is achieved by a

drawing operation. Initially the brass disc 12 is flat and circular. The peripheral portion is engaged by the rings which, for clarity, in Figure 2 are shown schematically spaced from one another but in practice an interference fit is achieved. The periphery of the brass disc 12 is thus drawn down between the rings to form a rigid mounting.

Figure 2 shows schematically an electric circuit for driving the piezo assembly. A first connecting wire 20 is connected by electrical solder 21 to an outer peripheral portion of the piezoceramic disc 12B. A second flexible electrical connection wire 22 is connected by electrical solder 23 to the bottom wall of the outer ring 11. The electrical wires 20 and 22 are connected to an electrical circuit 23 which is of conventional form and provides an electrical drive signal. The electrical circuit 23 includes an auto transformer arrangement and a high current electronic switch, the device being powered by a suitable battery.

The assembly shown Figures 1 to 3 is adapted to be mounted in casing 14 which acts to provides an acoustic chamber 15 outside the brass plate 12A and an acoustic discharge port 16 as best shown in Figure 5.

The casing 14 can be of any suitable materials such as a plastics material and in the illustrated embodiment a flange 17 extends around the periphery of the casing and has a shoulder 18 defining an undercut into which the transducer assembly is snap fitted and adapted to be rigidly mounted. The unit including the casing, as shown in Figure 5 is adapted to be snap fitted into a mounting barrel 18 which at its free end has a nose cone 19 and an interior acoustic horn 20.

The utilisation of the horn structure shown in Figure 5 has been found to substantially increase the acoustic level of the signal. It is believed that a high pressure, small displacement signal in the acoustic chamber 15 is transformed by the horn to produce a low pressure but

large displacement signal which has high acoustic intensity. This can be a great benefit for many applications.

With the assembly as shown in Figure 5 provision in practice is made for the application of power to drive a transducer the details are not shown in the drawing.

As an alternative to the embodiment shown in Figures 4 and 5, the outer ring 11 could be omitted and instead the skirt 12C could be bonded to the inner ring 13 and the profile of the casing 14 adjusted so as to cause the skirt and the inner ring 13 together to be fitted within the flange 17 of the casing.

A further alternative is to omit the inner ring 13 and to bond the outer ring 11 to the skirt 12C.

The invention which will be claimed will be any of the novel arrangements described herein in any combination and may include, but is not necessarily limited, to the following:

1. An acoustic transducer assembly comprising a generally planar diaphragm having piezoelectric transducer material in a central portion and a mounting flange extending from a peripheral portion transversely to the generally planar diaphragm, and first and second mounting elements engaging and mounting the flange on its inner and outer sides respectively whereby an assembly is adapted to be mounted for acoustic output when the piezoelectric transducer is electrically driven.
2. An assembly as defined in paragraph 1 above and wherein the diaphragm is disc-shaped with the flange being a depending skirt extending approximately at right angles to the general plane of the diaphragm.
3. An assembly as defined in paragraph 2 and wherein the first and second mounting elements are respective rings and the skirt is of corresponding shape to be clamped between the rings in an interference fit.

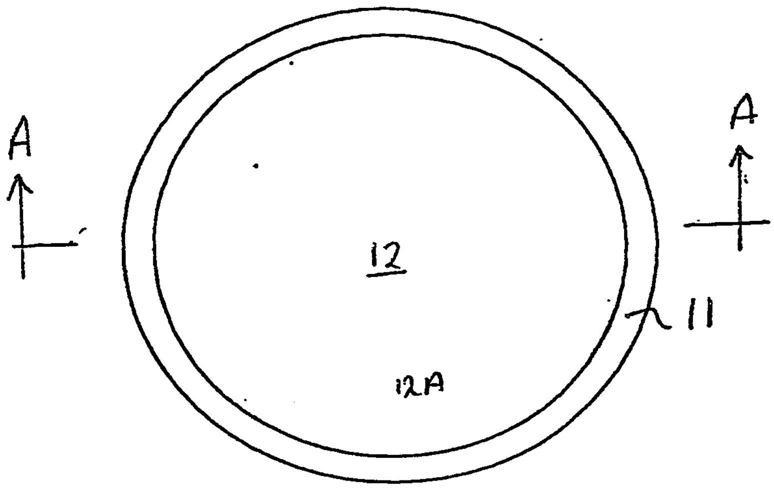


FIG 1

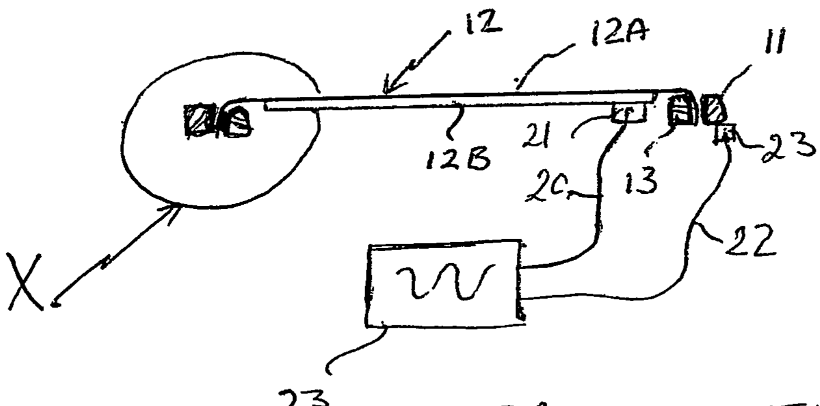
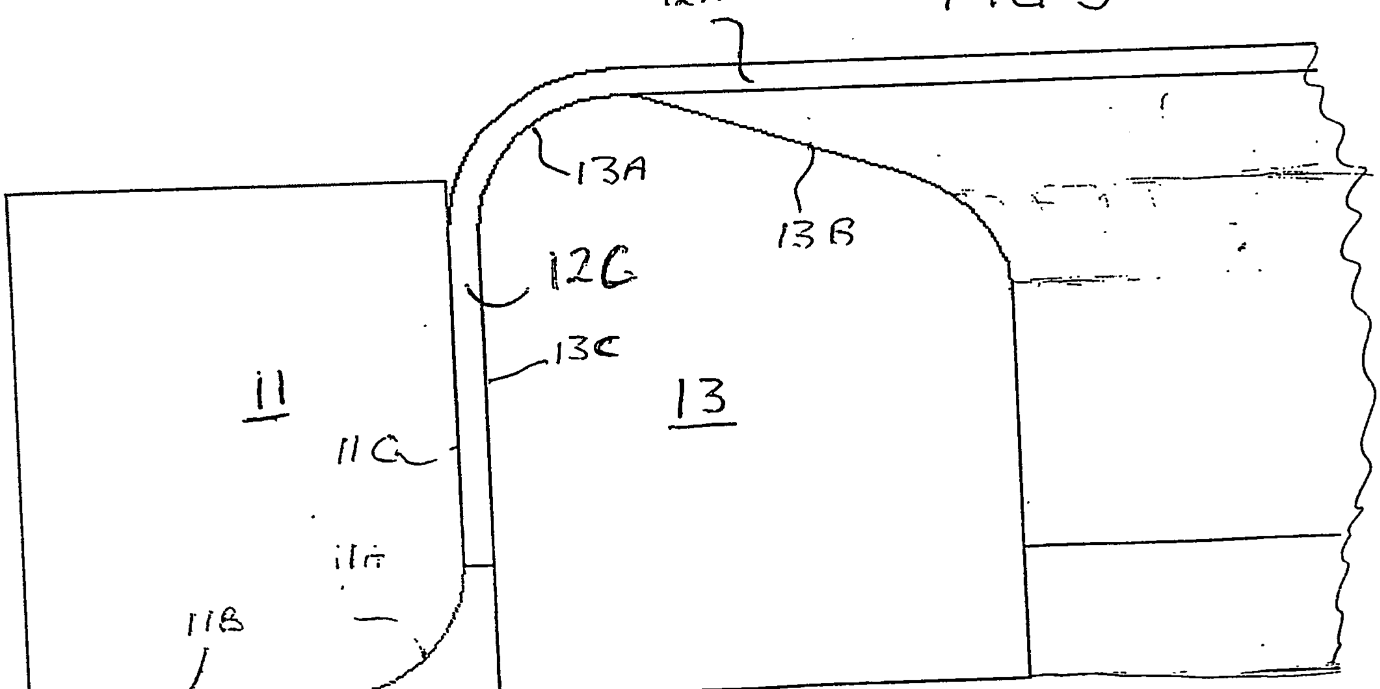


FIG 2

FIG 3



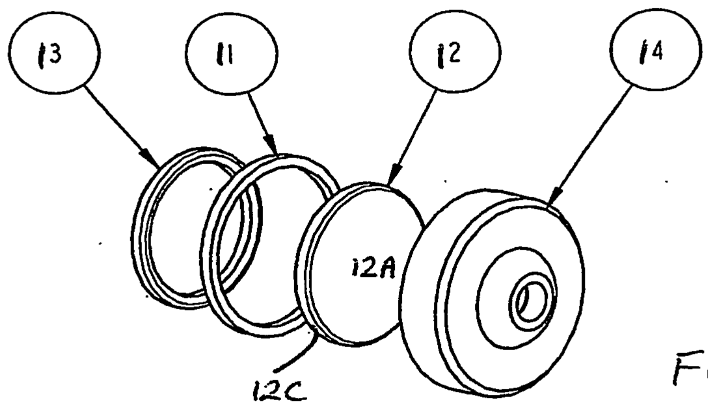


FIG 4

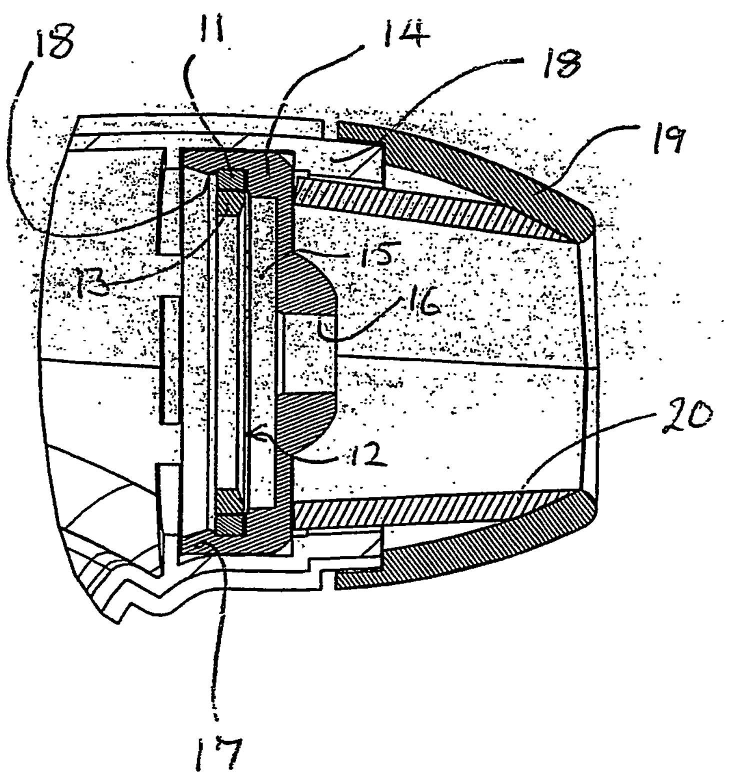


FIG 5